

WHAT IS CLAIMED IS:

1. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film;  
removing an oxide film from a surface of the semiconductor film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating after removing said oxide film.
  
2. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film;  
removing an oxide film from a surface of the semiconductor film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating in a reducing atmosphere after removing said oxide film.
  
3. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film;  
removing an oxide film from a surface of the semiconductor film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating in an inert gas after removing said oxide film.
  
4. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film;  
removing an oxide film from a surface of the semiconductor film by etching after the irradiation of the laser light; and

leveling the surface of the semiconductor film by heating in an atmosphere after removing said oxide film, a concentration of oxygen or a oxygen compound contained in said atmosphere is 10 ppm or less.

5. A method of manufacturing a semiconductor device comprising the steps of:
  - forming a semiconductor film comprising silicon over a substrate;
  - irradiating said semiconductor film with laser light for crystallizing said semiconductor film;
  - removing an oxide film from a surface of the semiconductor film by etching after the irradiation of the laser light; and
  - leveling the surface of the semiconductor film by heating in a reducing atmosphere after removing said oxide film, a concentration of oxygen or a oxygen compound contained in said reducing atmosphere is 10 ppm or less.
6. A method of manufacturing a semiconductor device comprising the steps of:
  - forming a semiconductor film comprising silicon over a substrate;
  - irradiating said semiconductor film with laser light for crystallizing said semiconductor film;
  - removing an oxide film from a surface of the semiconductor film by etching after the irradiation of the laser light; and
  - leveling the surface of the semiconductor film by heating in an inert gas after removing said oxide film, a concentration of oxygen or a oxygen compound contained in said inert gas is 10 ppm or less.
7. A method of manufacturing a semiconductor device comprising the steps of:
  - forming a semiconductor film comprising silicon over a substrate;
  - irradiating said semiconductor film with laser light for crystallizing said semiconductor film;
  - treating a surface of the semiconductor film with a hydrofluoric acid after the irradiation of the laser light; and
  - leveling the surface of the semiconductor film by heating after the treatment with said hydrofluoric acid.
8. A method of manufacturing a semiconductor device comprising the steps of:
  - forming a semiconductor film comprising silicon over a substrate;

irradiating said semiconductor film with laser light for crystallizing said semiconductor film;

treating a surface of the semiconductor film with a hydrofluoric acid after the irradiation of the laser light; and

leveling the surface of the semiconductor film by heating after the treatment with said hydrofluoric acid in a reducing atmosphere.

9. A method of manufacturing a semiconductor device comprising the steps of:

forming a semiconductor film comprising silicon over a substrate;

irradiating said semiconductor film with laser light for crystallizing said semiconductor film;

treating a surface of the semiconductor film with a hydrofluoric acid after the irradiation of the laser light; and

leveling the surface of the semiconductor film by heating after the treatment with said hydrofluoric acid in an inert gas.

10. A method of manufacturing a semiconductor device comprising the steps of:

forming a semiconductor film comprising silicon over a substrate;

irradiating said semiconductor film with laser light for crystallizing said semiconductor film;

treating a surface of the semiconductor film with a hydrofluoric acid after the irradiation of the laser light; and

leveling the surface of the semiconductor film by heating after the treatment with said hydrofluoric acid in an atmosphere, a concentration of oxygen or a oxygen compound contained in said atmosphere is 10 ppm or less.

11. A method of manufacturing a semiconductor device comprising the steps of:

forming a semiconductor film comprising silicon over a substrate;

irradiating said semiconductor film with laser light for crystallizing said semiconductor film;

treating a surface of the semiconductor film with a hydrofluoric acid after the irradiation of the laser light; and

leveling the surface of the semiconductor film by heating after the treatment with said hydrofluoric acid in a reducing atmosphere, a concentration of oxygen or a oxygen compound contained in said reducing atmosphere is 10 ppm or less.

12. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
irradiating said semiconductor film with laser light for crystallizing said  
semiconductor film;  
treating a surface of the semiconductor film with a hydrofluoric acid after the  
irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating after the treatment with  
said hydrofluoric acid in an inert gas, a concentration of oxygen or a oxygen compound  
contained in said inert gas is 10 ppm or less.
13. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
oxidizing a surface of the semiconductor film to form an oxide film thereon;  
irradiating said semiconductor film with laser light for crystallizing said  
semiconductor film wherein said semiconductor film is in contact with said oxide film during the  
irradiation of the laser light;  
removing the oxide film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating after removing said  
oxide film.
14. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
oxidizing a surface of the semiconductor film to form an oxide film thereon;  
irradiating said semiconductor film with laser light for crystallizing said  
semiconductor film wherein said semiconductor film is in contact with said oxide film during the  
irradiation of the laser light;  
removing the oxide film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating in a reducing  
atmosphere after removing said oxide film.
15. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
oxidizing a surface of the semiconductor film to form an oxide film thereon;

irradiating said semiconductor film with laser light for crystallizing said semiconductor film wherein said semiconductor film is in contact with said oxide film during the irradiation of the laser light;

removing the oxide film by etching after the irradiation of the laser light; and

leveling the surface of the semiconductor film by heating in an inert gas after removing said oxide film.

16. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
oxidizing a surface of the semiconductor film to form an oxide film thereon;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film wherein said semiconductor film is in contact with said oxide film during the irradiation of the laser light;

removing the oxide film by etching after the irradiation of the laser light; and

leveling the surface of the semiconductor film by heating in an atmosphere after removing said oxide film, a concentration of oxygen or a oxygen compound contained in said atmosphere is 10 ppm or less.

17. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
oxidizing a surface of the semiconductor film to form an oxide film thereon;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film wherein said semiconductor film is in contact with said oxide film during the irradiation of the laser light;

removing the oxide film by etching after the irradiation of the laser light; and

leveling the surface of the semiconductor film by heating in a reducing atmosphere after removing said oxide film, a concentration of oxygen or a oxygen compound contained in said reducing atmosphere is 10 ppm or less.

18. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
oxidizing a surface of the semiconductor film to form an oxide film thereon;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film wherein said semiconductor film is in contact with said oxide film during the irradiation of the laser light;

removing the oxide film by etching after the irradiation of the laser light; and leveling the surface of the semiconductor film by heating in an inert gas after removing said oxide film, a concentration of oxygen or a oxygen compound contained in said inert gas is 10 ppm or less.

19. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film wherein said laser light has a line-shaped cross section elongated in one direction;  
removing an oxide film from a surface of the semiconductor film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating after removing said oxide film.
20. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film wherein said laser light has a line-shaped cross section elongated in one direction;  
removing an oxide film from a surface of the semiconductor film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating in a reducing atmosphere after removing said oxide film.
21. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film wherein said laser light has a line-shaped cross section elongated in one direction;  
removing an oxide film from a surface of the semiconductor film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating in an inert gas after removing said oxide film.

22. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
oxidizing a surface of the semiconductor film to form an oxide film thereon;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film wherein said semiconductor film is in contact with said oxide film during the irradiation of the laser light and said laser light has a line-shaped cross section elongated in one direction;  
removing the oxide film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating after removing said oxide film.
  23. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
oxidizing a surface of the semiconductor film to form an oxide film thereon;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film wherein said semiconductor film is in contact with said oxide film during the irradiation of the laser light and said laser light has a line-shaped cross section elongated in one direction;  
removing the oxide film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating in a reducing atmosphere after removing said oxide film.
  24. A method of manufacturing a semiconductor device comprising the steps of:  
forming a semiconductor film comprising silicon over a substrate;  
oxidizing a surface of the semiconductor film to form an oxide film thereon;  
irradiating said semiconductor film with laser light for crystallizing said semiconductor film wherein said semiconductor film is in contact with said oxide film during the irradiation of the laser light and said laser light has a line-shaped cross section elongated in one direction;  
removing the oxide film by etching after the irradiation of the laser light; and  
leveling the surface of the semiconductor film by heating in an inert gas after removing said oxide film.

25. A method of manufacturing a semiconductor device according to any one of claims 1-24 further comprising a step of crystallizing said semiconductor film by heating before the irradiation of said laser light.

26. A method of manufacturing a semiconductor device according to any one of claims 1-24 wherein the step of leveling the surface of said semiconductor film is conducted by furnace annealing.

27. A method of manufacturing a semiconductor device according to any one of claims 1-24 wherein said semiconductor device is selected from the group consisting of a video camera, a digital camera, a projector, a goggle display, a navigation system for vehicles, a personal computer, and a portable information terminal.

28. A method of manufacturing a semiconductor device according to any one of claims 13-18 and 22-24 wherein said oxide film is formed by thermal oxidation.

29. A method of manufacturing a semiconductor device according to any one of claims 3, 6, 9, 12, 15, 18, 21 and 24 wherein said inert gas is nitrogen.

30. A method of manufacturing a semiconductor device according to claim 19 or 22 wherein the step of leveling is carried out in an atmosphere, which contains oxygen or a oxygen compound at 10 ppm or less.

31. A method of manufacturing a semiconductor device according to claim 20 or 23 wherein said reducing atmosphere contains oxygen or a oxygen compound at 10 ppm or less.

32. A method of manufacturing a semiconductor device according to claim 21 or 24 wherein said inert gas contains oxygen or a oxygen compound at 10 ppm or less.